BT MRE-IV(R/S)-06-23-2329 Reg. No. | | | | | | | | |

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B.Tech. Degree IV Semester Regular/Supplementary Examination in Marine Engineering June 2023

19-208-0402 THERMAL ENGINEERING AND HEAT TRANSFER

(2019 Scheme)

Time: 3 Hours Maximum Marks: 60

Course Outcome

On successful completion of the course, the students will be able to:

CO1: Understand the combustion of fuel gas turbine plant.
CO2: Calculate the work requirement for a given compression ratio.
CO3: Get an insight on conduction and apply it for optimizing the thickness of insulation.
CO4: Solve convective heat transfer problems and understand radiation heat transfer.
CO5: Attain information of parallel and counterflow heat exchangers and their design aspects.
Bloom's Taxonomy Levels (BL): L1 – Remember, L2 – Understand, L3 – Apply, L4 –Analysis, L5 – Evaluate, L6 – Create
PI – Programme Indicators

Answer ***ALL*** questions (5 × 15 = 75)

			Marks	BL	CO	PI
I.	(a)	Write a note on Adiabatic Flame Temperature (AFT).	5	L1	1	1.3.1
	(b)	Explain the working of Bomb calorimeter with help of a neat sketch.	10	L2	1	1.3.1
		OR				
II.	(a)	With help of a T-S diagram, explain how 'Intercooling' improves the thermal efficiency of open cycle gas turbine plant?	5	L1	1	1.3.1
	(b)	The air enters the compressor of an open cycle constant pressure gas turbine at a pressure of 1 bar and temperature of 20°C. The pressure of the air after compression is 4 bar. The isentropic efficiencies of compressor and turbine are 80% and 85% respectively. The air-fuel ratio used is 90:1. If flow rate of air is 3.0 kg/s, find: (i) Power developed (ii) Thermal efficiency of the cycle Assume $c_p = 1.0$ kJ/kgK and $\gamma = 1.4$ of air and gases, Calorific value of fuel = 41800 kJ/kg.	10	L2	1	1.3.1
III.		Derive the equation for minimum work input with perfect intercooling for a two-stage compressor.	15	L3	2	1.4.1
		OR				
IV.	(a)	A single cylinder reciprocating compressor has a bore of 120 mm and a stroke of 150 mm, and is driven at a speed of 1200 rpm. It is compressing air from a pressure of 120 kPa and a temperature of 20°C to a temperature of 215°C. Assuming polytropic compression with n = 1.3, no clearance and volumetric efficiency of 100%. Calculate: (i) Pressure ratio (ii) Indicated power (iii) Shaft power, with a mechanical efficiency of 80% (iv) Mass flow rate (v) Overall pressure ratio, if a second stage of equal pressure ratio added.	10	L3	2	1.4.1
	(b)	Briefly explain the working of 'Roots Blower' with a neat sketch.	5	L3	2	1.4.1

(P.T.O.)

			Marks	BL	CO	PI
V.		Derive general heat conduction equation for Cartesian coordinates.	15	L2	3	4.1.1
		OR				
VI.	(a)	Explain 'critical thickness of insulation'.	5	L2	3	4.1.1
	(b)	A furnace wall consists of 200 mm layer of refractory bricks, 6 mm layer of steel plate and a 100 mm layer of insulation bricks. The maximum temperature of the wall is 1150 °C on the furnace side and the minimum temperature is 40 °C on the outermost side of the wall. An accurate energy balance over the furnace shows that the heat loss from the wall is 400 W/m². It is known that there is a thin layer of air between the layers of refractory bricks and steel plate. Thermal conductivities for the three layers are 1.52, 45 and 0.138 W/m °C respectively. Find: (i) To how many millimeters of insulation brick is the air layer equivalent? (ii) What is the temperature of the outer surface of the steel plate?	10	L2	3	4.1.1
VII.		Air at 20 °C and at a pressure of 1 bar is flowing over a flat plate at a velocity of 3 m/s. If the plate is 280 mm wide and at 56°C, calculate the following quantities at x = 280 mm. (i) Boundary layer thickness (ii) Local friction coefficient (iii) Average friction coefficient (iv) Shearing stress due to friction (v) Thickness of the boundary layer (vi) Local convective heat transfer coefficient (vii) Average convective heat transfer coefficient (viii) Rate of heat transfer by convection (ix) Total drag force on the plate (x) Total mass flow rate through the boundary.	15	L2	4	3.1.1
		OR				
VIII.	(a)	What are the physical significance of Reynolds number (Re) and Prandtl number (Pr)?	5	L2	4	2.1.2
	(b)	Explain the concept of a black body.	5	L2	4	1.3.1
	(c)	Assuming the sun to be a black body emitting radiation with maximum intensity at λ=0.49 μm, calculate: (i) The surface tem erature of the sun. (ii) The heat flux at surface of the sun.	5	L2	4	4.3.1
IX.	(a)	A counter-flow double pipe heat exchanger using superheated steam is used to hot water at the rate of 10,500 kg/hr. The steam enters the heat exchanger at 180°C and leaves at 130°C. The inlet and exit temperatures of water are 30°C and 80°C respectively. If the overall heat transfer coefficient from steam to water is 814 W/m² °C, calculate the heat transfer area. What would be the increase in area if the fluid flows were parallel?	10	L3	5	4.3.1
	(b)	Differentiate between condenser and evaporator. Sketch the variation of temperature in both cases.	5	L3	5	2.1.2
		OR				
X	(a)	Derive an expression for LMTD of a parallel flow heat exchanger.	10	L3	5	4.1.1
	(b)	Describe the difference between a parallel flow and a counter flow heat exchanger, showing graphically how the temperatures vary with the length.	5	L3	5	2.1.2

Blooms's Taxonomy Levels
L1 – 7%, L2 – 53%, L3 – 40%,

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